

**Minutes of the Meeting of the  
Astronomy and Astrophysics Advisory Committee  
27-28 September 2017  
National Science Foundation, Arlington, VA**

**Members attending:**

Rachel Bean	Shane Larson
Dieter Hartmann	Rachel Mandelbaum (Vice Chair)
Buell Jannuzi (Chair)	John O'Meara
Kelsey Johnson	Constance Rockosi
Lisa Kaltenegger	William Smith
Brian Keating	Martin White
Shane Larson	

**Agency personnel:**

James Ulvestad, NSF-MPS	Ken Johnston, NSF-AST
Richard Green, NSF-AST	David Boboltz, NSF-AST
Chris Davis, NSF-AST	Allison Farrow, NSF-AST
Elizabeth Pentecost, NSF-AST	Donna O'Malley, NSF-AST
Ralph Gaume, NSF-AST	Denise Caldwell, NSF-PHY
Nigel Sharp, NSF-AST	James Whitmore, NSF-PHY
Diana Phan, NSF-AST	Vladimir Papatashvilli, NSF-Polar
Richard Barvainis, NSF-AST	Randy Phelps, NSF-OIA
Joseph Pesce, NSF-AST	Paul Hertz, NASA
Peter Kurczynski, NSF-AST	Hashima Hasan, NASA
Jim Neff, NSF-AST	Rita Sambruna, NASA
Linda French, NSF-AST	Kartik Sheth, NASA
Ed Ajhar, NSF-AST	Dominic Benford, NASA
Jonathan Williams, NSF-AST	Glen Crawford, DOE
Philip Puxley, NSF-AST	Patricia Crumley, DOE
Vernon Pankonin, NSF-AST	Helmut Marsiske, DOE
Thomas Wilson, NSF-AST	

**Others:**

Dana Lehr, AURA	Ashlee Wilkins, AAS
Lee Curtis, AURA	Rachel Osten, STSci
David Lang, NAS	James Lochner, USRA
Bethany Johns, AIP	Jeff Foust, <i>Space News</i>
Charles Lawrence, JPL	Alexander Witze, <i>Nature</i>
Steve Ritz, UCSD	Marcel Demarteau, Argonne Nat'l Lab
Roeland van der Marel, STSci	Ken Ganga, Univ. of Geneva
Eric Mamajek, Univ. of Rochester	Nick Siegler, JPL
Maximilian Rohde, MIT	Allison McGrath, NAS
Jason Rhodes, JPL	William Thomas

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**MEETING CONVENED 9:00 AM, 27 SEPTEMBER 2017**

The Chair called the meeting to order. Introductions were made.

The minutes from the June 22, 2017 meeting teleconference were approved by the Committee.

Elizabeth Pentecost, the AAAC Recording Secretary, reviewed the list of identified Conflicts of Interest (COIs) for the AAAC and asked that members send their conflicts to her.

The Committee selected October 23, 2017 as the date for a teleconference to discuss and accept the CMB S4 CDT report.

Elizabeth will send out a doodle poll to the Committee to gauge their availability for the late spring/early summer Committee meeting teleconference.

## **NSF**

James Ulvestad provided an update on Directorate for Mathematics and Physical Sciences (MPS) activities. He remains as acting Assistant Director (AD). Deborah Lockhart continues as Deputy AD. Wayne Van Citters retired as Senior Advisor for Facilities and that position is being advertised; Clark Cooper is on detail from the Office of Multidisciplinary Activities to the Directorate for Engineering. The new authorization act for NSF was passed by Congress in early January; there were no specific funding targets incorporated in the Congressional language, but there was language related to NSF awards being in the national interest and facility oversight; NSF has developed a response plan for all of the specific requirements. The FY2017 appropriation for NSF was passed by Congress in early May (with >5 months left in the fiscal year); the budget was essentially flat relative to FY2016. The spending is complete for FY2017; Daniel K. Inouye Solar Telescope (DKIST) and Large Synoptic Survey Telescope (LSST) construction were fully funded in FY2017. There was an initial hiring freeze for four months; a preliminary agency reform plan was due June 30 and a more detailed plan will be in the FY2019 budget request.

The FY2018 Presidents Budget Request (PBR) for NSF is \$6.65 billion, an ~11% reduction; for MPS, there was a reduction of ~10% overall in the FY2018 PBR. Congress passed a Continuing Resolution through December 8 at approximately FY2017 funding levels. There is continued investment in NSF research infrastructure; for MPS, this includes DKIST, LSST, Laser Interferometer Gravitational-wave Observatory (LIGO), and the Atacama Large Millimeter/submillimeter Array (ALMA). For MPS, the CAREER request was kept relatively stable; there were targeted REU reductions. The major research facilities are core to MPS and these need to be protected. The highest priority facilities are fully funded with small reductions to a few facilities in transition. There were reductions in mid-scale and instrumentation programs.

Ralph Gaume provided an update on NSF activities. Ralph Gaume was Acting Division of Astronomical Science (AST) Division Director (DD), with Edward Ajhar as Acting AST Deputy Division Director (DDD), until September 18 when Richard Green became the new AST Division Director and Dr. Gaume reverted to his role as DDD. AST was able to hire two Program Directors for the Spectrum Management program as well as a Program Director for the grants program. NSF moved its headquarters from Arlington, VA to Alexandria, VA starting in late August; MPS moved over the extended Labor Day weekend and the last moving group is this weekend.

Ralph Gaume presented a number of science and facilities highlights. NSF participated heavily in the Great American Eclipse that occurred on August 21, 2017; NSF provided funding for the Citizen Continental-America Telescope Eclipse (CATE) project, led by Matt Penn of NSF's National Solar Observatory, which used a set of 68 identical telescope sites along the path of totality manned by citizen scientists. Images taken every 10 seconds (with 2 arcsecond resolution) resulted in a 90-minute movie of eclipse (coronal) data. AST program officers observed the eclipse from various locations around the country. The DES collaboration (supported jointly by NSF and DOE) analyzed the first year of imaging data from the Dark Energy Camera on the National Optical Astronomy Observatory (NOAO) Blanco

telescope. The VLA has begun a new sky survey which is anticipated to detect 10 million objects; this will require ~5500 hours of observing time. Meanwhile, ALMA has been observing outflows from AGB stars, measuring mass outflow rates ( $10^{-5}$  solar masses/yr) and other characteristics.

With regard to its Individual Investigator Program, AST received 637 proposals in response to a proposal call in November 2016. Panel reviews are complete and all awards have been made; the proposal funding rate for FY2017 was ~19.3%, a slight increase from FY2016. AST is running a “no proposal deadline” pilot for the Planetary/Exoplanetary and Solar portions of the Astronomy and Astrophysics Research Grants (AAG) program; the pilot will continue in FY2018. The success of this pilot will be assessed at the end of the year. The Mid-Scale Innovations Program (MSIP) solicitation has been released for FY2018, though the Advanced Technologies and Instrumentation (ATI) and Partnerships in Astronomy and Astrophysics Research and Education (PAARE) deadlines have been postponed with the programs being reviewed. A new Major Research Instrumentation (MRI) solicitation is expected in FY2018.

AST will need to plan for the possibility of no budget increases for the balance of the decade. There is a need to balance facilities, small and mid-scale programs, and individual investigator grants programs. The FY2018 PBR attempts to do this. There is a Continuing Resolution through December 8; sequestration is due to return in FY2018.

The 2012 Portfolio Review report recommended a balance of small, medium, and large programs that would require divestment of a number of operating telescopes from the AST budget; the report referred to the removal of the funding of telescopes from the NSF/AST budget. The Mid-decadal survey committee strongly supported this balance. Several telescopes slated for divestment have developed partnerships. These include the Kitt Peak National Observatory (KPNO) 2.1m telescope, which is run by a Caltech-led consortium for Robo-AO, initially for a period FY2016-2018; the Mayall telescope, which is slated for the Dark Energy Spectroscopic Instrument (DESI); the Wisconsin-Indiana-Yale-NOAO (WIYN) telescope, where NOAO’s share of telescope time will be used for NASA-NSF Exoplanet Observational Research Programs (a NASA instrument has been selected); the Long Baseline Observatory (LBO)/VLBA, which separated from the National Radio Astronomy Observatory (NRAO) in FY2017 and for which a Memorandum of Agreement with the U.S. Navy is in place, the Navy providing 50% of the funding; and the Global Oscillation Network Group (GONG) and Synoptic Optical Long-term Investigations of the Sun (SOLIS) projects, with SOLIS removed from Kitt Peak for refurbishment and an interagency agreement with the National Oceanic and Atmospheric Administration (NOAA) in place so that NOAA share the operating costs of GONG. Because of the major changes to the operations of several of these facilities, NSF must conduct Environment Impact Statement (EIS) processes as well as National Historic Preservation Act (NHPA) consultation and Endangered Species Act (ESA) consultation processes. These activities are now being pursued for the Arecibo Observatory (the issuance of a Record of Decision is targeted for 2017; the Final EIS was published in August); the Sacramento Peak (SacPeak) Observatory (a university consortium of operators is being put together, with NSF funding the New Mexico State University for transition to the consortium; the Draft EIS is expected to be released in Fall 2017); and the Green Bank Observatory (the EIS process began on October 19, 2016, the draft EIS is expected to be released early Fall).

Vernon Pankonin provided a status update on NCOA (National Center for Optical-Infrared Astronomy) planning. NCOA is the organizational governance and management framework by which NSF-funded OIR assets will transition into a single organization that will include the National Optical Astronomy Observatory (NOAO), the Gemini Observatory, and the planned LSST operations. Both NOAO and Gemini are currently managed as independent centers by AURA. LSST operations will include NSF, DOE, and domestic and international partners’ funding; first operations funding begins in FY 2019 with ramp-up to steady state in FY 2023. NOAO will transition into the NCOA organization at the start of FY2019; Gemini Observatory and LSST Operations will be incorporated in NCOA at the same time.

Three independent funding lines will be maintained, for Gemini, LSST operations, and a third for all other activities. A review of the plan submitted by AURA will take place in October. The Gemini Board is being consulted about the plan and will be engaged at their November meeting. The plan will go to the NSB and the NSF Director for approval of the NCOA concept. The implementation of NCOA would start in Spring 2018 with operations to formally begin in October 2018. NCOA implementation would continue into 2019.

Nigel Sharp provided a status update on LSST. Technical progress is very good, though the Project team is very busy. Although both costs and schedule contingency are tight, construction is on track to complete on time and within budget. The Joint NSF-DOE annual progress review was held in early September. The review committee found that an enormous amount of work had been accomplished and progress is impressive. The project has an excellent team of people and the many project participants and organizations are functioning well as a single team. LSST has robust management processes. Site construction is going well. The weather was terrible but has improved. The Telescope Mount Assembly will be shipped to the summit in summer 2018. The surrogate mirror has been machined and is ready; the support systems are under test. A new data management project manager has been hired. The data management re-plan was completed and budget approval is pending. New management structures are in place; there will be an external review in July. The camera, which is being fabricated by DOE, is coming along nicely even with some challenges. The biggest next challenge for the agencies is the operations proposal, submitted in August and scheduled for initial programmatic review in December.

David Boboltz provided a status update on DKIST. The Sun, our most important astronomical object, is a laboratory for stellar astrophysics, it drives the space weather that impacts the Earth, and is a laboratory for plasma physics, i.e., magnetic fields and fusion experiments. DKIST will be the world's flagship facility for ground-based solar physics. The DKIST construction award (Major Research Equipment and construction [MREFC] and American Recovery and Reinvestment Act [ARRA]) was made in January 2010. Because of the permitting process, the final access to the site was not granted until November 2012. The 30-month delay required a re-baseline of the project, increasing the cost from \$298M to \$344.12M. The FY17 funding for DKIST was approved at \$20M (\$18.3M awarded in April and \$1.7M of contingency withheld for future allocation); the project is 78% complete. The last extra wide load taken to the summit was accomplished in August 2017. There have been several oversight reviews since the 2015 Project Execution Plan review, the Large Facilities Office (LFO)-led software quality assurance review, the AST-led project execution and construction status review, and the LFO-led independent risk assessment. There will be a series of critical science plan workshops over the next year or two that will be open to community participation that will explore the science cases for DKIST.

## **NASA**

Paul Hertz provided an update on NASA activities. The President has nominated James Bridenstine, the US House Representative from Oklahoma, to be the next NASA Administrator. Mr. Bridenstine serves on the House Armed Service Committee and the Science, Space, and Technology Committee. Hearings have yet to be scheduled.

The FY2017 appropriation and FY2018 budget request provide funding for NASA astrophysics to continue its programs, missions, projects, research, and technology. The total funding for the Astrophysics Division, including the James Webb Space Telescope, remains at ~\$1.35B. This fully funds Webb for an October 2018 launch<sup>1</sup>, funds Wide Field Infrared Survey Telescope (WFIRST) formulation,

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<sup>1</sup> After this AAAC meeting, NASA announced that the James Webb Space Telescope would launch between March and June 2019. The reserves in the Webb planning budget fully cover Webb for a launch between March and June 2019.

Explorers mission development, operating missions, increased funding for R&A, suborbital missions and new suborbital capabilities, continued technology development, and mission studies. The FY17 consolidated appropriation was less than the planning budget and there were reductions to the plans. The FY18 PBR balances the current science and future missions; Congressional markups, if enacted, would put that balance at risk. Progress is being made toward the recommendations made in the 2010 Decadal Survey. NASA is conducting large and medium mission concept studies for the 2020 Decadal Survey.

The FY18 PBR supports a Science Mission Directorate (SMD)-wide CubeSat/SmallSat initiative that uses smaller, less expensive satellites to advance science in a cost-effective manner. The budget reflects more efficient operations of the Hubble Space Telescope, without an impact to science, and reflects efficiencies realized by the Stratospheric Observatory for Infrared Astronomy (SOFIA) in the past few years; SOFIA will participate in the 2019 Astrophysics Senior Review. The budget does not include WFIRST review recommendations. The FY18 appropriation markups follow the Decadal Survey; Webb must be \$533.7M but cannot overrun and STEM activation must be \$44.0M. Astrophysics receives \$1,355.7M in the FY18 House markup, an increase of \$5.3M over the request.

Astrophysics CubeSats are implemented as part of the R&A program; proposals are submitted just like proposals for balloon payloads and sounding rocket payloads. Astrophysics selected two CubeSats this year; the augmentation will support ~1 astrophysics CubeSat selection per year.

The Astrophysics Division has several postdoctoral fellowship programs: Sagan, Hubble, and Einstein. A single combined fellowship program that selects ~24 fellows annually will be instituted. The program will be administered for NASA by the Space Telescope Science Institute (STScI). Awards will be made through host institutions and, starting in 2018, an institution may only host five fellows at any one time. There will be a single review of applicants to the fellowship program.

To address the problem of low selection rates, the Astrophysics Division now competes its Astrophysics Theory Program (ATP) in alternate years. The program budget remains the same. This should increase the selection rate close to that recommended in the 2015-2016 report of the Astronomy and Astrophysics Advisory Committee (AAAC). With an annual ATP competition in 2010-2016, only about 17% of the requested year-1 funding could be awarded. Competing the program only in even years would reduce the burden on reviewers and proposers.

NASA is maintaining a cadence of 4 Astrophysics Explorers AOs per decade, as recommended by the Decadal Survey and validated by the Midterm Assessment. The most recent Astrophysics Explorers Program Announcement of Opportunity (AO) released in September 2016, was for Medium-Class Explorers (MIDEX) and Mission of Opportunity (MO) proposals; three MIDEX proposals and three MO proposals were selected in August 2017 for a 9-month competitive Phase A study with a down-select in early 2019. The next Astrophysics Explorers Program AO will be for a Small Explorers (SMEX) and MO and is targeted for release in early 2019. A subsequent Astrophysics Explorers Program AO is for a MIDEX and MO and is targeted for release in late summer 2021.

The Neutron star Interior Composition Explorer (NICER) launched on June 3, 2017 and started its science in July. The instrument and spacecraft bus for the Transiting Exoplanet Survey Satellite (TESS) have been completed and integrated. The observatory environmental testing started in September and will be complete by the end of 2017. Delivery to Kennedy Space Center is expected in late January 2018 with a launch readiness date in March 2018. Webb remains on track for an October 2018 launch. The program remains within the replan budget. The project completed its spacecraft bus integration with the sunshield. Integration of the spacecraft and the science payload is expected in early 2018. An independent review of WFIRST was recommended by the National Academies. The committee was formed in April 2017 to make sure the technical requirements, scope, and cost/schedule were understood, reasonable, and well

aligned and to establish that the management processes in place were adequate; are the benefits of the coronagraph to NASA objectives commensurate with the cost and cost risk of development? The committee report is due in mid-October.

NASA is initiating large and medium mission concept studies as input for the 2020 Decadal Survey. NASA has appointed Science and Technology Development Teams (STDTs) and initiated four large mission concept studies as well as studies of medium-sized mission concepts. NASA will submit final reports and the results of the NASA cost assessment to the 2020 Decadal Survey Committee.

## **DOE**

Glen Crawford gave an update on DOE activities. The FY 2018 High Energy Physics (HEP) PBR (\$672.7M) is down (House appropriations bill is flat and the current Senate bill has an increase, relative to FY2017) but still aims to continue the successful Particle Physics Project Prioritization Panel (P5) priorities within the available budget by preserving the vision and modifying the execution. All projects continue, some with delays. The highest priority P5 projects are supported with least adjustment possible to scope and schedule. Research is maintained at 40% of the program budget. Operations support for ongoing experiments is reduced to make this possible. Other efforts across Research, Facility Operations, and Projects have scope reduced or schedules delayed, based on factors including the P5 report strategy and project maturity.

Operating experiments will continue to advance and produce science results. Priority is on executing the four P5 recommended Major Items of Equipment (MIE) projects, currently in fabrication phase: LSSTcam, DESI, LUX-Zeplin (LZ), and SuperCDMS (Cryogenic Dark Matter Search) -SNOLAB. The FY2018 PBR prioritizes efforts on LZ, slows DESI and SuperCDMS-SNOLAB. Efforts are also underway to plan the next phase. HEP is laying the groundwork for the future, i.e., Cosmic Microwave Background-Stage 4 (CMB-S4) which starts later in the P5 plan and opportunities for small projects; R&D funds are very limited. Language in both the House and Senate is supportive of Large Hadron Collider (LHC) HL-LHC Accelerator project, the HL-LHC Atlas and CMS upgrade projects, the Long-Baseline Neutrino Facility (LBNF) and the related Deep Underground Neutrino Experiment (DUNE), and Cosmic Frontier projects.

Through ground-based telescopes, space missions, and deep underground detectors, research at the cosmic frontier aims to explore dark energy and dark matter. Program thrusts include the study of the nature of dark energy, direct detection searches for dark matter particles, cosmic-ray and gamma-ray studies, the Cosmic Microwave Background (CMB), and computational cosmology. Related efforts funded by other programs in HEP include theory and detector development. Currently the Dark Energy program consists of the Dark Energy Survey (DES), LSST (camera), and DESI. For dark matter detection, several third-generation experiments are underway. CMB experiments are supported as part of the core particle physics program. HEP has research-only activities on Euclid, WFIRST, and supernovae surveys.

Dr. Crawford presented some science highlights. The LUX collaboration (LZ precursor) has published experimental constraints on the spin-dependent WIMP particle interactions with nucleons and on solar axions and galactic axion-line particles. The results provide a 90% confidence level upper limit on the WIMP interaction cross section, a factor of 6 improvement over previous LUX spin-dependent results and the most sensitive constraints to date for WIMP-neutron interactions. The High Altitude Water Cherenkov (HAWC) project is an all-sky survey looking for  $\gamma$ -ray annihilation and decay, quantum gravity effects on propagation of  $\gamma$ -rays, and particle acceleration in extreme magnetic and gravitational fields. There have been six publications in the last two months including a catalog of 39 sources.

HEP has started Cosmic Visions groups to allow interactions with small HEP community groups. There are groups for CMB, dark energy, and dark matter direct detection. The groups are looking toward planning for the 2020 Decadal Survey. The next P5 is anticipated to convene after the large projects, HL-LHC upgrades and LBNF/DUNE are baselined. The U.S. “Snowmass” process would begin in ~2019 to inform a new P5 in the early 2020s to develop a strategy for the next 10-year timeframe.

Typically, the total of all requests for research funding is 2-3 times more than is available. For FY2017, 31 proposals were received and 18 were funded. The Comparative Review funding opportunity annual call was this past summer. The Early Career program is open to university faculty and laboratory scientists. The comparative review of the DOE laboratories research program is held every 3-4 years; the next review should be in 2019.

### **AAAC Annual Report Feedback**

Richard Green (NSF), Paul Hertz (NASA), and Glen Crawford (DOE) provided feedback on the AAAC Annual Report.

### **NSF**

The AAAC recommended that DOE, NSF, and NASA continue their successful cooperation in Astronomy and Astrophysics. NSF will continue cooperation and collaboration with NASA and DOE to exploit synergies and shared scientific priorities in astronomy and astrophysics. Current examples of collaboration with NASA include co-sponsorship of the Decadal Survey, joint NSF-NASA Federal Advisory Committee Act (FACA) review panels (e.g. the AAAC), cooperation on space weather and solar research, joint ground-space observations of astrophysical objects, collaboration on the exoplanet research program (WIYN 3.5m telescope), cooperation on Near Earth Object detection and characterization (Arecibo, Green Bank, and future LSST Observatories), and semi-annual joint NSF-NASA staff meetings. Current examples of collaboration with DOE include the Dark Energy Camera, Dark Energy Survey Instrument (DESI), LSST, and the CMB Task Force.

The AAAC continues to support NSF/AST’s efforts to grow and develop the MSIP program, provided this is done while maintaining a balanced portfolio of investments by NSF/AST. NSF/AST established the Mid-Scale Innovations Program (MSIP) program to create opportunities for mid-scale projects otherwise not commensurate with existing programs. In the context of the reduced agency budget request, the recommendation for balance was taken very seriously; to maintain the quality of center operations and allow for the possibility of some funds above the request level from the Congressional appropriations process, the MSIP request was reduced for 2018. The solicitation may be released only in alternate years.

The AAAC concurs with the New Worlds New Horizons Astronomy Mid-term Assessment (NWNH-AMA) recommendation that the NSF facility divestment process be moved forward and that the agencies work to ensure that individual investigators are funded, in order to capitalize on and leverage the full capabilities of the large projects that represent such important and substantial investments by the agencies. The AAAC supports the NSF approach of working to divest facilities to partners or non-federal organizations that will continue to operate them as scientific facilities.

The AAAC supports efforts by the Association of Universities for Research in Astronomy (AURA), NOAO, LSST, and NSF to implement the recommendations of the OIR System Report. AST acknowledges that implementation of these recommendations will be constrained by the need to maintain a balanced investment across the portfolio of NSF/AST. In March 2016, AST asked NOAO to either plan for or carry out the tasks in the recommendations that are relevant to NOAO. Most of the tasks required

resources above the NOAO base budget, and therefore required supplemental funding. In July 2016, NOAO submitted to NSF a plan to accomplish the tasks with an estimate of the resources required. The plan noted that a total of ~\$5 million over 3-4 years above the NOAO base would be needed. The plan is being funded in supplement installments as funding is available.

The AAAC recommended that the agencies should consider coordinating their separate efforts on advising on the use and protection of the electromagnetic spectrum to better protect access to the electromagnetic spectrum for astronomical and astrophysical research. AST has brought on two new program officers to concentrate on spectrum management. They will spearhead the coordination efforts.

In formulating their programs for FY 2018, the AAAC recommend that NSF, NASA and DOE should strive to maintain viable research grant programs and preserve the highest priority decadal survey recommended programs. The reduced budget envelope for 2018 necessitated difficult choices to maintain a resilient program. The significant cut to MSIP was a conscious choice to provide some shielding for the grants program. Should the final appropriation exceed the request, the high priority for restoration in the AST budget is the research grants.

## **NASA**

The AAAC recommended that DOE, NSF, and NASA continue their successful cooperation in Astronomy and Astrophysics. DOE, NSF, and DOE will continue to coordinate their programs, working jointly where appropriate, which will lead to continued successful cooperation in astronomy and astrophysics.

The AAAC recommended that the three agencies begin to develop a plan for including multiple stakeholders to consider the costs and benefits of coordination of LSST, WFIRST, and Euclid on the broad science areas these missions will advance. NASA, NSF, and DOE have formed a Tri-Agency Group to discuss the possible implementation –and cost –of joint pixel analysis for data from LSST, Euclid, and WFIRST. NASA, NSF, and DOE have all charged and funded their implementation centers with developing a set of requirements, as well as a cost proposal, for implementing joint pixel analysis.

The AAAC supports the recommendations of NWNH and NWNH-AMA that the NASA Astrophysics Division execute at least four Announcements of Opportunity for the Explorer program this decade, followed mission selection, to preserve this valuable program of agile, low-cost missions in space. NASA plans to issue four Explorers AOs during 2012-2021, each of which will be concurrent with an AO for Missions of Opportunity.

The AAAC supports the continued exploration, with the support of the agencies, into future directions and experiments, missions, and programs to be considered for support by the 2020 decadal survey. NASA has initiated four large mission concept studies, each of which will be well studied, by a community-based STDT and a Center-led engineering team, and independently costed before being submitted to the Decadal Survey Committee for consideration. NASA has initiated ten medium mission concept studies, each of which will be studied by a PI-led science and engineering team and receive an independent cost assessment before being submitted to the Decadal Survey Committee.

The AAAC recommended that the agencies work with the National Academies to ensure a timely beginning to the next decadal survey, along with updates to the structure as recommended by NWNH-AMA. NASA, NSF, and DOE have been working with the Committee on Astronomy and Astrophysics (CAA) for two years to ensure a timely beginning to the next Decadal Survey.



The AAAC recommended that in formulating their programs for FY 2018, NSF, NASA and DOE should strive to maintain viable research grant programs and preserve the highest priority decadal survey recommended programs. The President's budget request for NASA Astrophysics maintains the funding levels of recent years and includes funding for growth in the research grant programs and continued execution of NASA's plan for implementing the 2010 Decadal Survey.

The AAAC recommended that NASA carefully monitor the impact of the planned changes to the prize fellowship and ATP solicitations (reduction in the number of prize fellowships offered annually and change in the frequency of ATP solicitations to every other year) to ensure that specific subfields within astronomy and astrophysics, such as theory, are not disproportionately affected. NASA will monitor the breadth of subfields supported through the NASA Hubble Fellowship Program and the Astrophysics Theory Program, and NASA will report back to the AAAC annually.

## **DOE**

All three agencies recommended sustaining a balanced and coordinated investment in the observational, theoretical, and computational research, technology development, and major projects and facilities, that are required to achieve the goals of NWNH. This includes the completion of construction, deployment, successful operation, and support of the researchers using the Daniel K. Inouye Solar Telescope (DKIST), the James Webb Space Telescope (JWST), the Large Synoptic Survey Telescope (LSST), and the Wide Field Infrared Survey Telescope (WFIRST). More broadly, providing (sometimes in partnership with others) the necessary support of US researchers and our most critical facilities, those identified in NWNH and associated reviews and reports, is essential to realizing the full scientific potential of the activities envisaged by NWNH. For DOE, this means supporting the completion of LSST, planning for the operations phase, and supporting dark energy research efforts.

US agencies are working well together to support the priorities of the astronomy and astrophysics research community, both in collaboration on large managed projects and through coordination of diverse research programs. All current and planned cosmic surveys intend to publicly release their data and to provide suitable access tools which will further enhance the impact of these experiments. The AAAC recommended that DOE, NSF, and NASA continue their successful cooperation in astronomy and astrophysics. DOE will continue cooperating. The tri-agency group considering LSST, WFIRST, and Euclid has begun the important process of coordinating between agencies by considering key parts of the dark energy science case for these missions and possible means of increasing the effectiveness of the missions in this area. They also recommend that the three agencies begin to develop a plan for including multiple stakeholders to consider the costs and benefits of coordination of LSST, WFIRST, and Euclid on the broad science areas these missions will advance. DOE will continue to work within the Three Agency Group (TAG) to coordinate efforts and support working towards a plan forward.

Major flight and construction programs may be harmed by continued uncertainty in the budget, leading to cost overruns and schedule slips. The AAAC urged that special attention be paid to these programs at the time that the FY 2017 budget was finalized and the FY 2018 budget was formulated. In formulating their programs for FY 2018, NSF, NASA and DOE should strive to maintain viable research grant programs and preserve the highest priority decadal survey recommended programs. DOE-HEP is following the P5 strategic plan, which overlaps with the recommendations from the decadal survey. As recommended by P5, DOE-HEP is striving to support research at ~ 40% of its budget.

The Committee briefly discussed the topics and items they would like to see on the agenda for the January meeting, including updates from the Agencies, the NSF Physics Division and NSF Polar programs, a CAA update on planning for the decadal survey, and a WFIRST review update. The January meeting will

be an opportunity to start working on the annual report.

**MEETING ADJOURNED AT 4:15 PM, 27 SEPTEMBER 2017**  
**MEETING RECONVENED AT 9:00 AM, 28 SEPTEMBER 2017**

**CMB-S4**

Charles Lawrence (Jet Propulsion Lab), chair of the Cosmic Microwave Background-Stage 4 (CMB-S4) Task Force, provided an update on the group's activities. The Conceptual Design Team (CDT) was asked to develop a concept for implementing a ground-based CMB-S4 experiment. The CDT was asked to deliver the science requirements and their rationale, the measurement and technical requirements derived from the science requirements, a project strawman concept, and options and alternatives for concept design, staging, and schedule, R&D development needed, and cost ranges for the strawman concept. The CDT will provide a final report to the Committee by October 2017 for consideration; the reports will be discussed and approved by the AAAC before formal transmittal to the agencies. The CDT has had weekly telecons and five face-to-face meetings since December. The group will give options for the use of existing telescopes that will be deployed prior to CMB S4 and alternative configurations with larger telescopes that would yield gains in the cluster science. The costing model is divided into three parts: pre-project R&D, the construction project, and post-project operations. Cost estimates are based on costs for deployed instruments, estimated costs for instruments being designed now, or bottom-up estimates by experts, scaled to CMB-S4 using simple parametric models. The process is well underway and the CDT is starting to consider strawman concept options; simulations are iterating to higher levels of realism. CMB-S4 will be a single experiment and collaboration; two sites are being explored for an eventual experiment, the South Pole and the Atacama.

**Euclid/LSST/WFIRST Coordination**

Jason Rhodes provided a report on Euclid/LSST/WFIRST coordination activities. All three projects are moving forward toward the onset of operations on similar timescales. While there is strong overlap in the science planned for these three facilities, their designs are highly complementary. A combined analysis of the data from all three will provide a significant enhancement in scientific return; this will probably require joint processing at the pixel level. There is a Tri-Agency, tri-project working Group (TAG) to explore this option; the initial reports from the technical subgroups will appear this Spring. LSST/Euclid coordination requires international agreements and careful examination of data rights. In 2015, the TAG endorsed an effort at defining the scientific and technical benefits of coordination. A Euclid/LSST Letter of Intent is being drafted that is expected to be completed this fall; it will be followed by an MOU for early data sharing by next summer. LSST/WFIRST coordination is also being done at the project level and primarily required agency and inter-team discussions. WFIRST data have no proprietary period which simplifies data rights issues. There is a strong overlap between WFIRST Science Investigation Teams and the LSST science groups. WFIRST contributed three sections to the LSST observing strategy white paper; this paper will be the mechanism for requesting new simulations of LSST observing strategy.

The TAG commissioned a report on how joint pixel-level data processing could be done in the US and what work is needed to make that happen. George Helou (IPAC) coordinated a report recommending a 4-stage approach. The report recommends that the next step be a scoping study of work needed to fulfill joint processing; work on Phase 2 started in July 2017. The goal is to deliver a final Phase 2 report to the agencies by June 2019. If Phase 3 starts in September 2019 and lasts three years, the system will be ready in September 2022, just in time for LSST and Euclid first data releases. A comprehensive list of use cases and requirements is targeted for end of November 2017. The TAG has focused primarily on

cosmology but they recognize there are larger communities and are making efforts to engage those communities.

A Tri-Agency Tri-Project Cosmological Simulations (TACS) task force was formed in May 2017. There is representation from the US and Europe, with members of Euclid, WFIRST, and LSST. The TACS's charge has six tasks for investigation: common supercomputing infrastructure, flagship numerical simulations, simulation studies, synthetic sky maps, systematic effects, and advanced statistical methods. All of the tasks are being investigated in parallel. Bi-weekly telecons are being held to share progress and updates, and a first task report is expected in March 2018.

### **Other Business**

The AAAC again briefly discussed planning for the January 2018 meeting. They discussed the topics that they would like to see presented at the meeting as well as who should present at the meeting.

**MEETING ADJOURNED AT 12:00 PM, 28 SEPTEMBER 2017**